

## CHAPTER 2

### BASIS OF FLOOR SLAB ON GRADE DESIGN

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#### 2-1. Stresses.

The structural design of a concrete floor slab on grade is primarily controlled by the stresses caused by moving live loads and in some cases the stationary loads. Stresses in floor slabs on grade resulting from vehicular loads are a function of floor slab thickness, vehicle weight and weight distribution, vehicle wheel or track configuration, modulus of elasticity and Poisson's ratio of concrete, and modulus of subgrade reaction of supporting material. The volume of traffic during the design life is important for fatigue considerations. The floor slab design procedure presented herein is based on limiting the critical tensile stresses produced within the slab by the vehicle loading, as in TM 5-822-6/AFM 88-7, Chap. 1. Correlation studies between theory, small-scale model studies, and full-scale accelerated traffic tests have shown that maximum tensile stresses in floor slabs will occur when vehicle wheels are tangent to a free edge. Stresses for the condition of the vehicle wheels tangent to an interior joint where the two slabs are tied together are less severe than a free edge because of the load transfer across the two adjacent slabs. In the case of floor slabs, the design can be based on the control of stress at interior joints. Exceptions to this assumption for interior joint loading occur when a wheel is placed at the edge at doorways or near a free edge at a wall.

#### 2.2 Vehicle-imposed loads.

For determining floor slab design requirements, military vehicles have been divided into three general classifications: forklift trucks, other pneumatic and solid tired vehicles, and tracked vehicles. The relative severity of any given load within any of the three classifications is determined by establishing a relationship between the load in question and a standard loading. Floor slab design requirements are then established in terms of the standard load. Other stresses such as restraint stresses resulting from

thermal expansion and contraction of the concrete slab and warping stresses resulting from moisture and temperature gradients within the slab, due to their cyclic nature, will at times be added to the moving live load stresses. Provision for these stresses that are not induced by wheel loads is made by safety factors developed empirically from full-scale accelerated traffic tests and from the observed performance of pavements under actual service conditions.

#### 2-3. Stationary live loads.

The maximum allowable stationary live load is limited by both the positive bending moment stress under the load and the negative bending moment stresses occurring at some distance from the load.

*a. Positive bending moments.* Stresses due to positive bending moment are relatively simple to compute by using Westergaard's analysis\* of elastically supported plates. An appropriate safety factor is applied to determine allowable stresses due to these loads because environmentally imposed stresses must also be accounted for when considering stationary loads.

*b. Negative bending moments.* The effect of negative bending stress is somewhat more difficult to determine. A slab on an elastic subgrade will deform under loading somewhat like a damped sine curve in which the amplitude or deformation of successive cycles at a distance from the loading position decreases asymptotically to zero. Thus, there exists some critical aisle width where the damped sine curves from parallel loading areas are in phase and additive. In this situation, the negative bending moment stresses will become significant and must be considered. Therefore, allowable stationary live loads were established to include the effects of negative moment bending stresses. These calculations are reflected in the tabulated values of allowable stationary live loads.

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\* Westergaard's analysis is actually for plates on a liquid foundation, sometimes called a Winkler foundation. There is a distinct difference between the structural behavior of plates on a liquid and on an elastic foundation. In many textbooks, the term "beam on elastic foundation" is actually "beam on liquid foundation."

**2-4. Wall loads.**

There are situations where a wall is placed on a new thickened slab or- on an existing concrete floor slab on grade. Walls weigh from several hundred to several thousand pounds per linear foot. The design table used for determining thicknesses required under walls is developed by Staab (see Biblio) and

is based on the theory of a beam on a liquid foundation subjected to concentrated loads. Three loading conditions are considered: loads at the center of the slab, loads at a joint, and loads at the edge of the slab. The widths of thickened slabs are developed together with the recommended transitions.